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ABSTRACT

Intended for use by all general metals instructors in the Metropolitan Nashville Public Schools, this guide provides a sequential listing of course content and scope. A course description provides a brief overview of the content of the courses offered in the general metals program. General course objectives are then listed. Outlines of the course content are presented for these courses: general metals I, II, and III. Suggested time and specific objectives are provided for each major topic. A listing of resource materials, which includes textbooks and filmstrips, is appended. (YLB)

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GENERAL METALS

SCOPE AND SEQUENCE

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VOCATIONAL EDUCATION

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CE043738

Metropolitan Public Schools

Nashville Davidson County, Tennessee

Charles O. Frazier, Director

FOREWORD

This scope and sequence guide, developed for the General Metals Vocational Education program, represents an initial step in the development of a systemwide articulated curriculum sequence for all vocational programs within the Metropolitan Nashville Public School System. It is a direct result of needs expressed by teachers, parents, and the business community for sequential structure within the vocational education curriculum. An articulated vocational curriculum allows a student to move from one level of instruction to the next without repeating learning tasks already mastered, and without experiencing gaps in the presentation of relevant instructional material.

A goal of this curriculum effort is to provide teachers a usable guide based on input from the teachers. The initial step was an identification of course content, with all teachers having an opportunity to contribute. What follows is a publication using the teachers' contributions: a sequential listing of objectives and skills for each program offering.

This guide does not include all specific resource materials that may be used to assist students in acquiring minimum competencies. It is to serve as a guide for the sequence of course content and scope of what is to be taught. This guide content is extremely important and its use is encouraged. The suggested competencies and resource materials allow instructors an opportunity to be creative and resourceful in meeting the needs of individual programs and students.

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The Committee:

Instructors	Schools
Donald R. Dorris	Stratford

Committee Coordinator: Preliminary Committee and Revision Committee-Robert Roehl-Whites Creek

Program Area: Forrest P. Wilson

Editorial Consultant/Design/Layout

Judy Beier - Commerical Art Instructor - Maplewood
Mary Jo Grady - Commercial Art Instructor - Pearl/Cohn
Joy Binkley - Editing
Dr. Jim Lorenz - Third Party Evaluator
Exemplary Project Staff
Vocational Program Coordinators

Printing/Binding/Typesetting/Technical Assistance

Sam White - Printing Instructor - Overton
Jesse Ray - Printing Instructor - Whites Creek
Cleve Yokely - Printing Instructor - Stratford
Kenneth Ford - Manager - Metropolitan Public School Binding
Robert Tucker - Director - Metropolitan Public School Printing Department
Jean Porter - Publications Specialist - Department of Communication and Community Relations
Debbie Fulghum - Typesetter - Department of Communication and Community Relations

INTRODUCTION

This guide is an outline of information to promote an understanding of the General Metals field for vocational instructors and guidance personnel.

The following outline is developed from state approved textbooks, curriculum guides, industrial survey needs, U. S. Air Force university curriculum and other resources.

It is further recognized that additions or modifications may be neccessary in order to accommodate the individual differences within each program.

COURSE DESCRIPTION

The course in General Metals provides instruction in many phases of work dealing with the use of metal. Basic principles of sheet metal, welding and machine shop are explored.

A review of metals and their characteristics, including composition, form, strength, durability, working qualities and uses form the basis on which the course is built. Practice will be gained in soldering, oxyacetylene cutting and welding, shielded metal arc, gas tungsten arc and gas metal arc welding. Use of fasteners and finishing of metal products by grinding, machining, polishing, priming, painting and etching make up part of the study.

Students enrolled in the General Metals course learn the processes and procedures used in the design and construction of a great variety of metal products. They learn to use and make precision measurements and layouts for many different types of projects which are similar to those produced in metal fabricating industries. Students learn to make use of arithmetic, algebra, plane geometry and trigonometry and principles of design. They also learn to read shop drawings and blueprints.

Students have the opportunity to participate in VICA leadership training and in local, state and national skills competitions.

GENERAL COURSE OBJECTIVES

1. To teach students to operate machines safely in all three areas of work
2. To teach proper care and use of tools and equipment used in the field of welding, sheet metal and machine shop.
3. To prepare students for employment in each work area
4. To motivate students to become skilled craftspersons
5. To stress the importance of good citizenship and work attitudes

COURSE CONTENT FOR GENERAL METALS I

(First Semester)

I. Introduction and orientation (1 week)

Specific objectives:

To learn the history of metals
To become familiar with shop rules and regulations
To become familiar with the grading system that is used

A. Becomes familiar with history of metal work

B. Learns shop rules

C. Completes personal data sheet

D. Becomes familiar with work release forms

E. Understands course objectives

F. Participates in orientation and tour of shop

G. Reviews careers in General Metals

H. Knows grading system

I. Understands make-up work requirements

II. Safety (1 week)*

Specific objectives:

To recognize unsafe situations and be able to state rules for shop and personal safety
To select the correct fire extinguisher for the classes of fire
To match safety color codes with statements about their use

A. Understands terms

B. Understands federal safety color code

C. Understands personal safety rules

* Note: Safety is a continual process throughout the whole course.

II. **Safety continued:**

D. Understands general shop safety rules

E. Understands importance of maintaining a clean and orderly shop

F. Understands classes of fires

G. Understands components of fire triangle

H. Becomes familiar with types of fire extinguishers

III. **Vocational Industrial Clubs of America (1 week)***

Specific objectives:

To understand the purposes of the VICA organization
To identify the symbols of the VICA emblem and tell what each represents

A. Learns purpose, motto and pledge

B. Learns colors

C. Learns symbols

D. Participates in election of officers

E. Plans activities for the year

IV. **Hand tools (2 weeks)**

Specific objectives:

To name all the hand tools in the shop and identify their use
To know the danger points as well as the safety factors of hand tools

A. Knows line indentation markers

B. Knows screwdrivers

C. Knows hammers and mallets

D. Knows pliers, clamps and vises

E. Knows wrenches

* NOTE: VICA is a continual process throughout the whole course.

IV. Hand tools continued:

F. Knows squares

G. Knows hand snips

H. Knows hand hacksaws

I. Knows cold chisels

J. Knows files

K. Knows punches

L. Knows hand and breast drills

M. Knows notchers, seamers and crimpers

N. Knows stakes, plates and dollies

V. Shop math (2 weeks)

Specific objectives:

To add, substract, multiply and divide fractions and decimal equivalents
To work simple ratio and proportions
To be able to read and interpret a decimal equivalent chart

A. Shows proficiency in addition of decimals and fractions

B. Shows proficiency in subtraction of decimals and fractions

C. Shows proficiency in multiplication of decimals and fractions

D. Shows proficiency in division of decimals and fractions

E. Shows proficiency in conversion of fractions to decimals and decimals to fractions

F. Shows proficiency in reducing fractions

G. Learns decimal equivalent chart

VI. Measuring tools for sheet metal (1 week)

Specific objectives:

Specific objectives continued:

To identify and describe the types of rules and tapes used by the sheet metal worker
To select and use a rule properly
To use the correct tape to make inside, outside and circumference measurements

A. Selects and uses six foot zig-zag rule

B. Selects and uses circumference rule

C. Selects and uses push-pull steel tape

D. Selects and uses steel tape and woven tape

VII. **Practical layout for the sheet metal shop (1 week)**

Specific objectives:

To define geometric terms and principles and draw them out on paper
To list geometric shapes and methods used in sheet metal

A. Defines and demonstrates knowledge about geometric principles

B. Defines and demonstrates knowledge about geometric line and angle division

C. Defines and demonstrates knowledge about geometric constructions

VIII. **Views and projections (1 week)**

Specific objectives:

To list the views that can be taken of an object
To make various views necessary for pattern development and select surface identifications

A. Becomes familiar with views and projections

B. Learns how to revolve each view into a vertical plane

C. Learns how to align views

D. Understands hidden views

E. Understands auxiliary views

F. Completes tests

IX. Pattern development (1 week)

Specific objectives:

To be able to name common geometric solids
To list methods of pattern development
To indicate the types of jobs that can be done by each method
To identify and develop a true length line
To lay out simple patterns

A. Identifies common solids

B. Understands parallel line method

C. Understands radial line method

D. Understands triangulation

E. Understands true lengths

F. Lays out simple patterns

X. Elbows (2 weeks)

Specific objectives:

To list parts of the round and square pipe elbows
To develop pattern stretchouts for the round pipe elbow and the square or rectangular pipe elbow
To calculate the number of segments, segment angles and curved surface in an elbow

A. Develops elbows

B. Develops round pipe elbows

C. Develops square or rectangular pipe elbow

D. Develops square pipe elbow with square throat and heel

E. Develops square pipe elbow with curved throat and heel

XI. Offsets (2 weeks)

Specific objectives:

To list general rectangular pipe

Specific objectives continued:

To list the different types of offset fittings that can be developed with square or rectangular pipe
To develop the pattern stretchout for a plain square pipe offset
To develop the cheek and heel patterns for a plain square pipe offset

A. Develops round pipe offset

B. Develops square pipe offset

C. Develops square pipe offset with a curved throat and back

XII. Tees (2 weeks)

Specific objectives:

To name the standard tees used in sheet metal
To describe the ways a tee is formed
To name the system that uses tees
To develop the patterns for a 90 degree round pipe tee
To develop the patterns for an inclined round pipe tee
To develop the patterns for a 90 degree square pipe tee
To develop the patterns for a square pipe tee on a pitch

A. Develops tees

B. Develops 90 degree pipe tee

C. Develops inclined round pipe tee

D. Develops 90 degree pipe tee with clinch edges

E. Develops square pipe tee on a pitch with clinch edges

XIII. Taper joints (1 week)

Specific objectives:

To name the various types of round pipe taper joints
To list the common types of transitions used in sheet metal work
To develop the patterns for a round pipe equal taper joint
To develop the patterns for a transition with three straight sides

A. Develops round equal taper joint

B. Develops transition joint

COURSE CONTENT FOR GENERAL METALS I

(Second Semester)

I. Semester overview (1 week)

Specific objectives:

To be sure all safety procedures are understood
To understand the importance of properly connecting seams and joints

A. Reviews safety procedures

B. Reviews seam and joint connections

II. Characteristics and control of airflow (2 weeks)

Specific objectives:

To understand airflow characteristics
To determine the dimensions of a duct system components
To fabaricate and install duct system components
To minimize the turbulence and resistence to airflow
To know how to use splitters and turn vanes to improve airflow

A. Understands characteristics of airflow through duct component

B. Fabricates and installs diverging and converging ducts

C. Fabricates and installs rectangular duct elbows

D. Fabricates and installs splitters in rectangular duct elbows

E. Fabricates and installs turn vanes in square elbows

F. Fabricates and installs deflecting damper in a duct system

G. Fabricates and installs volume dampers

H. Fabricates and installs diffusers, registers, grilles

III. Duct system (2 weeks)

Specific objective:

To fabricate, install and repair a complete duct system

III. **Duct sytem continued:**

A. Demonstrates preliminary planning

B. Demonstrates selecting sheet metal

C. Demonstrates trunkline A and plenum fabrication and installation

D. Demonstrates trunkline B fabrication and installation

E. Demonstrates trunkline C fabrication and installation

F. Demonstrates branch line fabrication and installation

G. Demonstrates return air duct fabrication and installation

H. Demonstrates selecting registers, grilles and diffusers

I. Demonstrates selecting louvers and dampers

J. Demonstrates selecting insulation

K. Demonstrates pattern layouts

L. Demonstrates forming and assembly

M. Demonstrates hanger fabrication and installation

N. Demonstrates planning for the installation

O. Demonstrates duct joint fabrication and installation

P. Demonstrates duct insulation

Q. Demonstrates installation of registers, grilles and diffusers

IV. **Stacks and ventilators (2 weeks)**

Specific objectives:

To fabricate, install and repair stacks and ventilators
To know how wind affects the efficiency of stacks and ventilators

A. Demonstrates stack and ventilator fabrication, installation and repair

B. Demonstrates draft diverter fabrication, installation and repair

C. Demonstrates wall thimble fabrication, installation and repair

IV. **Stacks and ventilators continued:**

D. Demonstrates roof jack fabrication, installation and repair

E. Demonstrates storm collar fabrication, installation and repair

F. Demonstrates vent cap fabrication, installation and repair

V. **Basic floor machines (1 week)**

Specific objectives:

To safely use any machine related to sheet metal work
To be able to spot hazards related to each machine

A. Operates and safely uses cutting tools

B. Operates and safely uses power shears

C. Operates and safely uses foot squaring shear (stomp shear)

D. Operates and safely uses box pan brake

E. Operates and safely uses slip roll

F. Operates and safely uses combination rotary machine

VI. **Seams, edges, hems (1 week)**

Specific objective:

To layout and form seams, edges and hems necessary to complete a project

A. Demonstrates laying out and forming hems

B. Demonstrates laying out and forming edges

C. Demonstrates laying out and forming seams

VII. **Layout and design (1 week)**

Specific objective:

To take a large sheet of metal and accurately layout a project without waste

A. Practices safety in handling sheet metal

B. Demonstrates layout on sheet metal

VII. **Layout and design continued:**

C. Demonstrates marking the patterns on sheet metal

D. Demonstrates sequence of operations in design and layout

VIII. **Soldering (1 week)**

Specific objectives:

To list the classes of solder
To select the proper flux for the job
To clean and form a copper
To tin a copper properly
To solder sheet metal seams properly

A. Understands furnaces

B. Understands and recognizes fluxes

C. Understands and recognizes coppers

D. Understands and recognizes solders

E. Understands and recognizes terminology

1. Soldering techniques

2. Sweating techniques

3. Skimming techniques

4. Tacking techniques

5. Tinning techniques

IX. **Study of metals (1 week)**

Specific objectives:

To define terms associated with metals
To identify shapes and be able to discuss the basics of metal identification
To write a metal analysis

A. Understands terms and definitions

B. Recognizes metals that can be welded

C. Identifies shapes of metal

X. **Types of welding and cutting (1 week)**

Specific objective:

To know and identify the different types of welding procedures

A. Understands and masters chart of welding and allied processes

B. Becomes familiar with procedures to be used

XI. **Oxygen acetylene cutting by hand (1 week)**

Specific objective:

To learn the proper and safe way to use oxygen and acetylene regulators, hoses and equipment

A. Demonstrates preparation of joints

B. Demonstrates safe use of equipment set-up

C. Demonstrates torch lighting

D. Demonstrates cutting a straight line and hole

XII. **Oxygen acetylene welding (1 week)**

Specific objectives:

To be able to fuse weld in any position
To oxygen acetylene weld in any position

A. Demonstrates fusion welding

B. Demonstrates fuse corner joint weld

C. Demonstrates fuse lap joint weld

D. Demonstrates fuse butt joint weld

E. Demonstrates butt joint weld

F. Demonstrates tee joint weld

G. Demonstrates weld using bronze filler rod

H. Demonstrates weld using mild steel filler rod

XIII. Automatic cutting torch (1 week)

Specific objective:

To safely perform cutting operations using the automatic cutting torch

A. Demonstrates safe use

B. Demonstrates equipment care

XIV. Shielded metal arc welding (2 weeks)

Specific objectives:

To exhibit a positive and safety attitude on a daily basis
To be able to select the proper electrode to prepare the metal to strike the arc
To be able to arc weld in all positions mild steel plate and pipe

A. Demonstrates safety in arc welding

B. Recognizes welding equipment and machines

C. Recognizes electrodes and their use

D. Demonstrates preparation of metal for joints

E. Demonstrates striking an arc

F. Demonstrates running practice beads

G. Demonstrates running stack beads

H. Demonstrates welding lap joints

I. Demonstrates welding tee joints

J. Demonstrates welding butt joints

K. Demonstrates welding 6" mild steel pipe

COURSE CONTENT FOR GENERAL METALS II

(First Semester)

I. Gas tungsten arc welding (TIG) (4 weeks)

Specific objectives:

To learn how to set up joints and equipment
To weld mild steel, stainless and aluminum using the TIG procedures
To learn how to select the correct current, polarity, tungsten, electrodes, filler metals and gases
To weld in all positions using the TIG process

A. Demonstrates safe use of TIG welders

B. Recognizes equipment and machines

C. Uses tungsten electrodes

D. Demonstrates preparation of metal for welding

E. Demonstrates preparation of the machine for welding

F. Reviews causes of poor welds

G. Demonstrates carrying a puddle on aluminum

H. Demonstrates welding a lap joint on aluminum

I. Demonstrates welding a tee joint on aluminum

J. Demonstrates welding a butt joint on aluminum

K. Demonstrates fuse welding a lap joint on stainless steel

L. Demonstrates fuse welding a tee joint on stainless steel

M. Demonstrates fuse welding a corner joint on stainless steel

N. Demonstrates welding a butt joint on stainless steel

O. Demonstrates fusing weld stainless steel pipe to flat stainless steel metal

P. Demonstrates welding stainless pipe using purge system

II. **Gas metal arc welding (MIG) (4 weeks)**

Specific objectives:

To define terms associated with GMAW
To identify gases, power sources and wire used to perform task
To be able to weld in all positions using steel and aluminum

A. Demonstrates safety in MIG welding

B. Understands MIG equipment

C. Demonstrates metal preparation

D. Understands causes of poor welds

E. Practices running beads

F. Demonstrates welding a tee joint (stack beads)

G. Demonstrates welding a lap joint

H. Demonstrates welding a butt joint

III. **Basic and semiprecision tools (1 week)**

Specific objective:

To be able to use different measuring devices to maintain a semiprecision measurement

A. Understands linear measurement

B. Demonstrates use of steel rule

C. Demonstrates use of short length rule

D. Demonstrates use of narrow rule

E. Demonstrates use of tape rule

F. Demonstrates use of hook rule

G. Demonstrates use of rule depth gauge

H. Demonstrates use of slide caliper rule

I. Demonstrates use of combination set

III. **Basic and semiprecision tools continued:**

J. Demonstrates use of inside and outside calipers

IV. **Precision (3 days)**

Specific objective:

To use micrometer to obtain a precision measurement

A. Understands reading decimals

B. Understands decimal equivalents

C. Demonstrates use of micrometer caliper

D. Demonstrates use of vernier micrometer

E. Demonstrates use of vernier caliper

F. Demonstrates use of vernier height gauge

V. **Bench tools (2 days)**

Specific objective:

To be able to prove the use of bench tools on a test

A. Understands use of bench tools

B. Demonstrates use of broaching tools

C. Demonstrates use of lapping tools

D. Demonstrates use of hand taps and dies

E. Demonstrates use of hand reamers

F. Demonstrates use of hand saws

VI. **Layout tools (3 days)**

Specific objectives:

To be able to layout a project using layout tools

A. Demonstrates scribing lines

VI. **Layout tools continued:**

B. Demonstrates layout for drills and folds

VII. **Drill presses (2 days)**

Specific objectives:

To be able to use different types of drills

A. Recognizes types of drill presses

B. Understands and demonstrates drilling fundamentals

C. Understands speeds, feeds and coolants for drills

D. Demonstrates cutters used on drill press

E. Demonstrates use of holding devices

VIII. **Engine lathes and facing (1 week)**

Specific objectives:

To be able to identify the parts of the lathe and their uses
To be able to select and use the proper tools to safely face off work in the lathe

A. Identifies lathe types and construction

B. Practices use of accessories

C. Practices use of attachments

D. Practices use of stops

E. Practices use of cutting tools, setups and operations

F. Practices use of right and left hand tools

G. Demonstrates mounting the work

H. Uses facing on the face plate

I. Demonstrates facing between centers

J. Demonstrates mounting centers

VIII. Engine lathes and facing continued:

K. Demonstrates mounting work between centers

IX. Straight and shoulder turning (1 week)

Specific objectives:

To be able to safely set up, rough turn and finish a product in the lathe
To safely turn a shoulder on the lathe

A. Demonstrates safety and use of setup

B. Demonstrates safety and use of rough turning

C. Demonstrates safety and use of reversing ends

D. Demonstrates safety and use of finish turning

E. Demonstrates safety and use of turning a shoulder

X. Knurling and cutting off (1 week)

Specific objectives:

To be able to select the different kinds of knurls
To safely perform the task of knurling
To safely cut off a piece of stock in the lathe

A. Practices turning a knurl (medium cut)

B. Practices cutting off a piece of stock

XI. Filing and polishing in lathe (1 week)

Specific objectives:

To safely use the file on the lathe while it is running
To safely use sand paper or cloth to polish stock on the lathe

A. Practices filing a piece of stock in the lathe

B. Practices polishing the piece of stock just filed

XII. Thread cutting and taper turning (1 week)

Specific objectives:

XII. Thread cutting and taper turning continued:

Specific objectives:

To be able to name terms, setup and turn thread on lathe
To be able to identify tapers, calculate and perform tasks

A. Understands thread terms

B. Practices setup for external turning

C. Understands kinds of tapers

D. Understands calculating tapers

E. Demonstrates taper turning with attachment

F. Demonstrates taper turning with compound rest

G. Demonstrates taper turning by off-setting the tail stock

XIII. Center drilling in the lathe (1 week)

Specific objectives:

To be able to setup the lathe for drilling, reaming and boring
To perform required tasks

A. Demonstrates drilling

B. Demonstrates reaming

C. Demonstrates boring

XIV. Turning internal threads (1 week)

Specific objectives:

To safely setup and turn internal threads on the lathe
To perform required tasks

A. Practices setup

B. Demonstrates use of center gauge

C. Demonstrates use of thread gauge

D. Demonstrates use of plug gauge

XIV. **Turning internal threads (1 week)**

E. Demonstrates use of threading formulas

COURSE CONTENT FOR GENERAL METALS II

(Second Semester)

I. **Milling machine (4 weeks)**

Specific objectives:

To identify and safely use the vertical mill using holding devices
To properly lubricate and care for equipment

A. Understands milling machine safety

B. Recognizes classes of mills

C. Understands parts and their functions

D. Practices lubrication and care of machine

E. Understands work holding devices

F. Practices use of attachments

G. Practices use of feeds and speeds

H. Practices use of cutting tools

I. Demonstrates climb milling

J. Understands and practices coventional milling

II. **Surface grinder (4 weeks)**

Specific objectives:

To setup and safely use the machine
To properly use the wheel dresser

A. Understands and utilizes safety

B. Recognizes parts

C. Demonstrates setups and operations

D. Practices parts measurements

III. **Tool post grinder (4 weeks)**

Specific objectives:

To setup the grinder on the lathe
To choose the proper wheel in relation to the speed
To select the proper pulleys and belts to set the speed
To do precision grinding on the lathe

A. Demonstrates safe use of tool post grinder

B. Selects and practices setup for lathe grinding

IV. **Heat treating (4 weeks)**

Specific objectives:

To heat treat tools made in the shop
To understand different ways to harden metal
To use the Rockwell Hardness Tester

A. Recognizes and practices safety with heat treating glasses and face shield

B. Understands and demonstrates techniques for hardening metal

C. Practices use of Rockwell Hardness Tests

V. **Projects (2 weeks)**

Specific objective:

To apply the skills learned to specific projects

A. Plans and develops projects

B. Understands project evaluation

COURSE CONTENT FOR GENERAL METALS III

(First Semester)

I. **Introduction (1 week)**

Specific objectives:

To give an overview of material to be covered this year
To become acquainted with job possibilities

A. Understands subject material to be covered

B. Explores career opportunities

II. **Heat treating and metallurgy (5 weeks)**

Specific objectives:

To heat treat tools made in the shop
To understand the different ways to harden metal
To know how to use a Rockwell Hardness Tester

A. Reviews safety with heat treatment

B. Understands grain structures

C. Demonstrates heat treating

D. Practices furnace safety

E. Performs hardness testing

III. **Forging (5 weeks)**

Specific objectives:

To forge weld and form tools for forging
To anneal, harden and temper formed tools

A. Practices safety with forge

B. Demonstrates proper use of equipment

C. Demonstrates form welding, tool forming, annealing, hardening, and tempering

III. **Forging continued:**

D. Demonstrates upsetting metal

E. Demonstrates drawing out metal

F. Demonstrates bending metal

G. Demonstrates twisting metal

H. Demonstrates fullering and swaging metal

I. Demonstrates punching holes

J. Demonstrates forging lap weld

IV. **Study of metals (5 weeks)**

Specific objectives:

To define terms associated with metals
To identify shapes and discuss the basics of metal identification
To write a metal analysis

A. Studies methods used in metal identification

B. Studies SAE/AISI number code for metals

C. Distinguishes between ferrous and non-ferrous metals

D. Classifies basic types of carbon steels

E. Understands importance of metallurgy

F. Analyzes low alloy, high tensile steel and low carbon steel differences

G. Analyzes properties of metals

H. Determines advantages of using aluminum

I. Recognizes aluminum welding difficulties

V. **Projects (2 weeks)**

Specific objective:

To use the skills learned to make metal objects

V. **Projects continued:**

A. Practices proper use of tools

B. Designs and constructs other projects

COURSE CONTENT FOR GENERAL METALS III

(Second Semester)

I. **Work experience (18 weeks)**

Specific objective:

To be exposed to live work experiences in the general metals trade

A. Practices maintenance work

B. Performs demand-type work

C. Participates in co-op experiences

RESOURCE MATERIALS

Textbooks

Giachino and Weeks. Welding Skills and Practices, 5th. Kalamazoo, Michigan: American Technical Publishers, 1976.

Meyer, Leo A. Sheet Metal Shop Practice. Alsip, Illinois: American Technical Publishing, 1975.

Repp, McCarthy. Machine Tool Technology. Bloomington, Illinois: McKnight Publishing, 1979.

Repp, McCarthy, Ludwig. Metalwork Technology and Practice. Bloomington, Illinois: McKnight Publishing, 1982.

Walker, John K. Modern Metal Working. South Holland, Illinois: Goodheart-Willcox, 1976.

Zinngrabe and Schumacker. Practical Layout for the Sheet Metal Shop. New York: Delmar, 1975.

Zinngrabe and Schumaker. Sheet Metal Hand Processes. New York: Delmar, 1974.

Zinngrabe and Schumaker. Sheet Metal Machine Processes. New York: Delmar, 1975.

Audio Visual

Filmstrips

Metal Work & Series - Riviting, Sheet Metal Machine, Sortering, etc., Overlay Transparencies by Milliken

Sheet Metal Lathe, Welding, Shaper, etc., RMI Media Production - 2 kits-filmstrips and cassettes

The Lathe Explained, Bergwell Productions - 6 films and cassettes

Tig Welding, Mig Welding, Metal Work Careers, Welding Safety, Arc Welding, Gas Welding, etc., Library Film Strip Center in Kansas - 6 filmstrips-33⅓ records